

SOLUBILITY CURVES

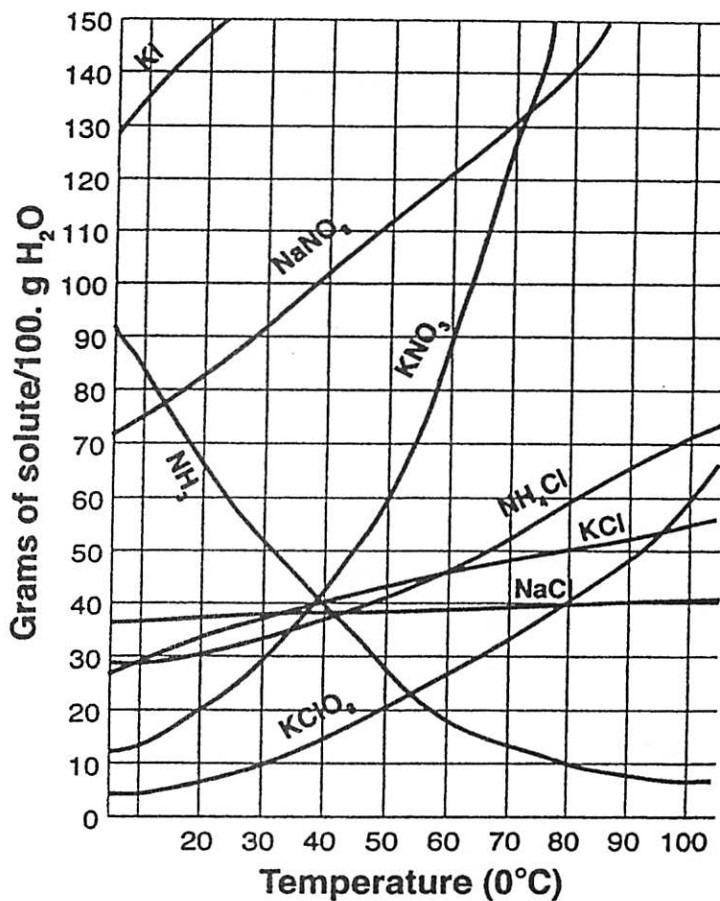
Name _____

Answer the following questions based on the solubility curve below.

- Which salt is least soluble in water at 20° C? _____
- How many grams of potassium chloride can be dissolved in 200 g of water at 80° C?

- At 40° C, how much potassium nitrate can be dissolved in 300 g of water? _____
- Which salt shows the least change in solubility from 0° – 100° C?

- At 30° C, 90 g of sodium nitrate is dissolved in 100 g of water. Is this solution saturated, unsaturated or supersaturated?



- A saturated solution of potassium chlorate is formed from one hundred grams of water. If the saturated solution is cooled from 80° C to 50° C, how many grams of precipitate are formed? _____
- What compound shows a decrease in solubility from 0° to 100° C? _____
- Which salt is most soluble at 10° C? _____
- Which salt is least soluble at 50° C? _____
- Which salt is least soluble at 90° C? _____

INTERPRETING DATA FROM SOLUBILITY CURVES

DIRECTIONS: Use the solid solubility curve given to you to solve the following problems.

To start, use your ion sheet to write formulas for the following compounds.

Potassium Nitrate _____

Sodium Chloride _____

Potassium Chloride _____

_____ 1) What is the solubility of potassium nitrate in 100 grams of water at 90°C?

_____ 2) What is the solubility of potassium chloride in 100 grams of water at 50°C?

_____ 3) What is the solubility of sodium chloride in 100 grams of water at 90°C?

_____ 4) What is the minimum temperature needed to dissolve 180 grams of potassium nitrate in 100 grams of water

_____ 5) At what temperature do potassium chloride and potassium nitrate have the same solubility?

_____ 6) If 110 grams of potassium chloride are mixed with 100 grams of water at 20 °C, how much will *not* dissolve?

_____ 7) If 250 grams of potassium nitrate are mixed with 100 grams of water at 80 °C, how much will *not* dissolve?

_____ 8) If 15 grams of potassium chloride are added to 100 grams of water at 30 °C, how much more must be added to make a saturated solution?

_____ 9) If 170 grams of potassium nitrate are added to 100 grams of water at 80 °C, how much more must be added to saturate the solution?

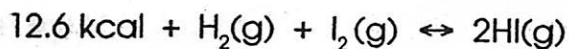
_____ 10) If 100 grams of water at 90 °C are saturated with potassium nitrate. If this solution is cooled to 30°C, how much of the solid will precipitate (change from the dissolved state to the solid state)?

_____ 11) How much potassium nitrate will dissolve in *50 grams of water* at 95 °C?

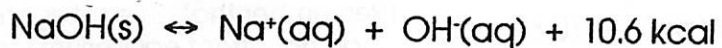
_____ 12) How much potassium chloride will dissolve in *25 grams of water* at 80 °C?

LE CHATELIER'S PRINCIPLE CONTINUED

Name _____



| Stress | Equilibrium Shift | [H ₂] | [I ₂] | [HI] |
|--------------------------|-------------------|-------------------|-------------------|-----------|
| 1. Add H ₂ | right | _____ | decreases | increases |
| 2. Add I ₂ | | | _____ | |
| 3. Add HI | | | | _____ |
| 4. Remove H ₂ | | _____ | | |
| 5. Remove I ₂ | | | _____ | |
| 6. Remove HI | | | | _____ |
| 7. Increase Temperature | | | | |
| 8. Decrease Temperature | | | | |



(Remember that pure solids and liquids do not affect equilibrium values.)

| Stress | Equilibrium Shift | Amount NaOH(s) | [Na ⁺] | [OH ⁻] |
|---|-------------------|----------------|--------------------|--------------------|
| 1. Add NaOH(s) | | _____ | | |
| 2. Add NaCl (Adds Na ⁺) | | | _____ | |
| 3. Add KOH (Adds OH ⁻) | | | | _____ |
| 4. Add H ⁺ (Removes OH ⁻) | | | | _____ |
| 5. Increase Temperature | | | | |
| 6. Decrease Temperature | | | | |

Concentration Worksheet

Calculate the molarities of the following solutions:

- 1) 2.3 moles of sodium chloride in 0.45 liters of solution.
- 2) 1.2 moles of calcium carbonate in 1.22 liters of solution.
- 3) 120 grams of calcium nitrite in 240 mL of solution.
- 4) 98 grams of sodium hydroxide in 2.2 liters of solution.
- 5) 45 grams of ammonia in 0.75 L of solution.

Calculate the percent by mass and molality of each of the following solution:

(The density of water is 1.0 g/ml)

- 6) 2.3 moles of sodium chloride in 500 g of water.
- 7) 1.2 moles of calcium carbonate in 1.22 liters of water.
- 8) 120 grams of calcium nitrite in 240 g of water.
- 9) 98 grams of sodium hydroxide in 2.2 liters of water.
- 10) 45 grams of ammonia in 0.75 L of water.

How many grams of each solute do you need to make the following aqueous solutions?

10) 2 L of 6 M HCl

11) 1.5 L of 2 M NaOH

12) 0.75 L of 0.25 M Na₂SO₄

13) 45 mL of 0.12 *m* sodium carbonate

14) 250 mL of 0.75 *m* lithium nitrite

15) 56 mL of 1.1 M iron (II) phosphate

MOLARITY (M)

Name _____

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Solve the problems below.

1. What is the molarity of a solution in which 58 g of NaCl are dissolved in 1.0 L of solution?

2. What is the molarity of a solution in which 10.0 g of AgNO_3 is dissolved in 500. mL of solution?

3. How many grams of KNO_3 should be used to prepare 2.00 L of a 0.500 M solution?

4. To what volume should 5.0 g of KCl be diluted in order to prepare a 0.25 M solution?

5. How many grams of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ are needed to prepare 100. mL of a 0.10 M solution?

MOLALITY (m)

Name _____

$$\text{Molality} = \frac{\text{moles of solute}}{\text{Kg of solvent}}$$

Solve the problems below.

1. What is the molality of a solution in which 3.0 moles of NaCl is dissolved in 1.5 Kg of water?

2. What is the molality of a solution in which 25 g of NaCl is dissolved in 2.0 Kg of water?

3. What is the molality of a solution in which 15 g of I_2 is dissolved in 500. g of alcohol?

4. How many grams of I_2 should be added to 750 g of CCl_4 to prepare a 0.020 m solution?

5. How much water should be added to 5.00 g of KCl to prepare a 0.500 m solution?

Solution Stoichiometry (Evil, you may also need a second sheet of paper)

H

1. How many moles of water form when 25.0 ml of 0.100 M nitric acid solution reacts with an excess of NaOH?
2. In the last lab, 10.0 ml of 3.00 M hydrochloric acid reacted with an excess of zinc. What is the maximum volume of hydrogen that can be collected via water displacement at 22.0°C and 745 torr?
3. A volume of 1.23 L of hydrogen iodide gas is bubbled through 450. g of a 0.891% solution of aluminum chloride. What volume of hydrogen chloride gas will be produced if the reaction takes place at 850. torr and 19.2°C?
4. A volume of 32.1 ml of a 0.198 M solution of silver acetate reacts with an equal volume of a 0.135 M ammonium carbonate solution. How many grams of the precipitate are formed?
5. Calcium hydroxide reacts with carbon dioxide to form water and calcium carbonate. If 75.0 ml of carbon dioxide (at STP) is bubbled through 1.00 L of a 0.200 M solution of the base, how much calcium carbonate will be produced if there is an 84.2% yield?

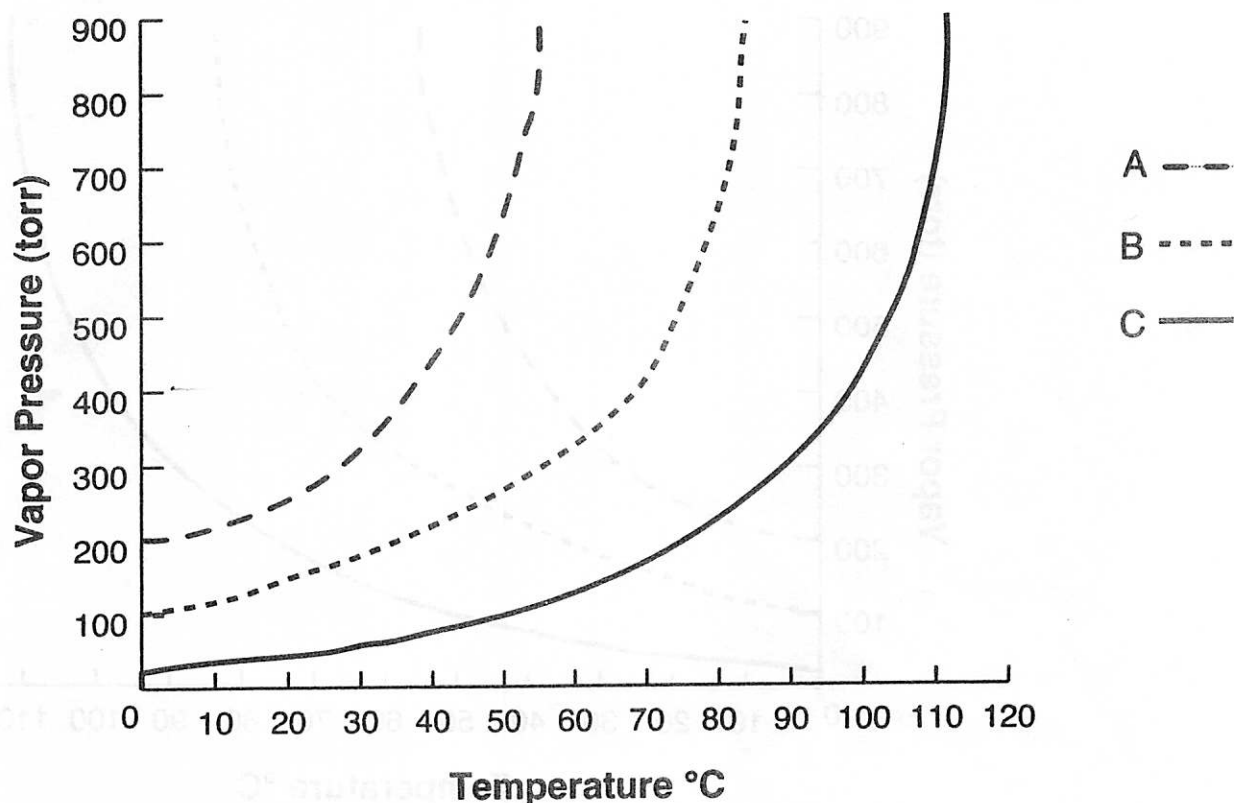
AF Solution Stoichiometry

1. How many moles of water form when 25.0 ml of 0.100 M nitric acid solution reacts with an excess of NaOH?
2. In the last lab, 10.0 ml of 3.00 M hydrochloric acid reacted with an excess of zinc. What is the maximum volume of hydrogen that can be collected via water displacement at 22.0°C and 745 torr? (Ignore water vapor pressure)
3. A volume of 1.23L of hydrogen iodide gas is bubbled through 200. mL of 0.100 M solution of aluminum chloride. What volume of hydrogen chloride gas will be produced if the reaction takes place at STP? (Ignore water vapor pressure)
4. If an excess of aluminum metal is dropped into a 1.20 L of 0.400 M copper (II) sulfate, what mass of copper metal will form? If only 15.2 g of copper form, what is the percent yield?

VAPOR PRESSURE AND BOILING

Name _____

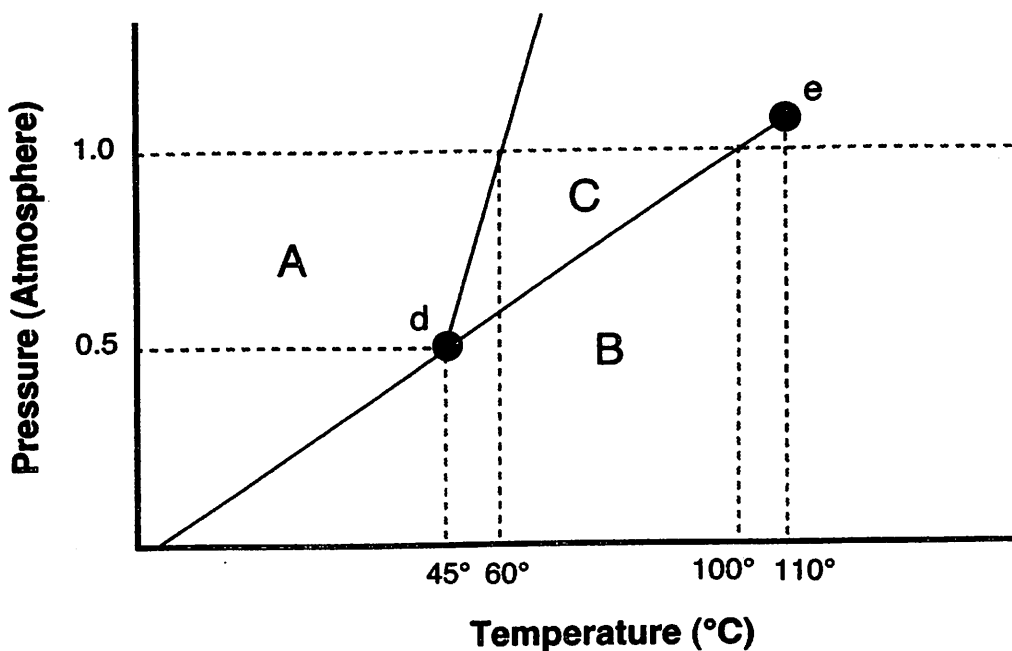
A liquid will boil when its vapor pressure equals atmospheric pressure. Answer the questions following the graph.



1. At what temperature would Liquid A boil at an atmospheric pressure of 400 torr? _____
2. Liquid B? _____
3. Liquid C? _____
4. How low must the atmospheric pressure be for Liquid A to boil at 35° C? _____
5. Liquid B? _____
6. Liquid C? _____
7. What is the normal boiling point of Liquid A? _____
8. Liquid B? _____
9. Liquid C? _____
10. Which liquid has the strongest intermolecular forces? _____

PHASE DIAGRAM

Name _____



Answer the following questions using the chart above.

1. What section represents the solid phase? _____
2. What section represents the liquid phase? _____
3. What section represents the gas phase? _____
4. What letter represents the triple point? _____
5. What letter represents the critical point? _____
6. What is this substance's normal melting point? _____
7. What is this substance's normal boiling point? _____
8. Above what temperature is it impossible to liquify this substance no matter what the pressure? _____
9. At what temperature and pressure do all three phases coexist? _____
10. Is the density of the solid greater than or less than the density of the liquid?

11. Would an increase in pressure cause this substance to freeze or melt? _____

EFFECT OF A SOLUTE ON FREEZING AND BOILING POINTS

Name _____

We use the following formulas to calculate changes in freezing and boiling point due to the presence of a nonvolatile solute. Freezing point is always lowered, boiling point is always raised.

$$\Delta T_f = m \times \text{d.f.} \times k_f$$

$$k_b \text{H}_2\text{O} = 0.52^\circ \text{C/m}$$

$$\Delta T_b = m \times \text{d.f.} \times k_b$$

$$k_f \text{H}_2\text{O} = 1.86^\circ \text{C/m}$$

m = molality of solution

k_f and k_b = constants for particular solvent

d.f. = dissociation factor (how many particles solute breaks up into: for a nonelectrolyte, d.f. = 1)

(Theoretical Dissociation Factor is always greater than observed effect.)

Solve the problems below.

1. What is the new boiling point if 25 g of NaCl is dissolved in 1.0 Kg of water?

2. What is the freezing point of the solution in Problem 1?

3. What are the new freezing and boiling points of water if 50. g of ethylene glycol (molecular mass = 62 g/mol) is added to 50. g of water?

4. When 5.0 g of a nonelectrolyte is added to 25 g of water, the new freezing point is -2.5°C . What is the molecular mass of the unknown compound?

Colligative Properties (some constants will need to be looked up)

1. Calculate the freezing and boiling points of an aqueous solution of 383 g of glucose in 400 g of water.
2. What mass of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, should be dissolved in 450. g of water to obtain a freezing point of -4.50°C ?
3. The boiling point of a solution containing 10.44 g of an unknown nonelectrolyte in 50.00 g of acetic acid is 159.2°C . What is the molar mass of the solute?
4. What is the boiling point of a solution of 8.69 g of sodium acetate dissolved in 15.0 g of water?
5. What mass of calcium chloride, when dissolved in 100. g of water, gives an expected freezing point of -5.00°C ?
6. A compound has the empirical formula CH_2O . When 0.0866 g is dissolved in 1.00 g of ether, the solution's boiling point is 36.5°C . Determine the molecular formula of this substance.